# TAPE BASED HIGH FIBER COUNT CABLE

## BACKGROUND OF THE INVENTION

### Field of the Invention

The present invention generally relates to the field of fiber optic cables, in particular the present invention is directed to a new and novel method and apparatus for supporting and packaging optical fibers.

### Discussion of Related Art

Optical fibers are very small diameter glass strands which are capable of transmitting an optical signal over great distances, at very high speeds, and with relatively low signal loss as compared to standard wire or cable networks. Optical fibers are used in many areas of technology, and because of this development, there is a growing need to have fiber optic cable configurations which can provide adequate support for the optical fibers, and which are sized so that they can be effectively used in various environments.

An example of a common fiber optic cable cross-section can be seen in Figure 1. At the center of the cable is a central strength member 1. The central strength member 1 can be made from a number of different materials, such as hard plastic, glass, or a glass reinforced composite and is used as a load bearing member for the cable, as well as for supporting the inner sides of buffer tubes 2 that are typically stranded around the central strength member in a helical path. Although Figure 1 shows six buffer tubes 2, the quantity can increase or decrease depending on the particular application the cable is to be used for. Within each buffer tube 2 is a plurality of individual optical fibers 3. The optical fibers 3 can be con-

figured in any number of ways. For example, within each buffer tube 2 there can be a stacked ribbon configuration (as shown in Figure 1) where each ribbon has a plurality of individual fibers and there are a number of ribbons. Alternatively, the fibers 3 can be configured as bundles inside the buffer tube. The configuration will greatly depend on the use and application of the cable. Finally, the outer jacket 4 provides protection to the internal components of the cable, while aiding to keep all of the components together. The outer jacket 4 provides protection from the adverse physical elements that a cable can be exposed to during its use and installation.

Conventional optical fiber configurations, as shown in Figure 1, use extruded thermoplastic materials for the outer jackets 4 and buffer tubes 2 to protect the fibers 3 and to create housings. Unfortunately, these materials contract too much at low temperatures causing deformation of the fibers. To minimize contraction, the diameter of the central strength member 1 can be increased or radial steel wires can be inserted in the jacket. Strength yarns 5 are also used to increase tensile strength. These additional elements increase the size of the cable and add to the overall cost. Thus, a high fiber count cable is needed that provides sufficient support for the optical fibers while not substantially increasing the cross-sectional size and weight of the cable.

## SUMMARY OF THE INVENTION

The present invention is directed to eliminating the above problems associated with the use of various thermoplastics and multiple components, to form optical fiber configurations. Thus, the invention improves the quality of the optical fiber cable while reducing the cross-section size, number of components and weight.

The present invention addresses the above problems by providing an optical fiber configuration and method. The optical fiber configuration comprises fibers that are grouped by buffer tubes using a lightweight fabric-type composite tape material to serve as a strength member. The configuration is manufactured by first providing a plurality of optical fibers upon the composite tape material. Gel or foamy glue is placed on the tape and is used as a filler and an adhesive to secure the optical fibers to the tape. A buffer tube is then formed by rolling the composite tape or helically wrapping the tape around the fibers such that the tape takes on a tube shape and surrounds the fibers. Furthermore, multiple buffer tubes may be bundled together to form a stack. This is done by providing an additional piece of composite material having gel on one side, and placing the buffer tubes on the gel side of the composite tape material. The stack is then formed by rolling the tape to enclose the buffer tubes while excess gel serves to fill in gaps. Multiple stacks may then be stranded to form a larger cable that uses another piece of composite tape material along with an additional rolling process, similar to that described above. The individual stacks may be formed to have a triangular or trapezoidal shape for efficient packaging.

Thus, the present invention provides an optical cable configuration with improved quality while reducing the cross-section size, number of components and weight. The configuration employs innovative geometry and cost-effective materials for both dielectric and armored optical fiber cables. The tape provides a way of supporting and manipulating the optical fibers without extensive reliance on extruded plastic tubes or additional strength members, resulting in a reduced diameter. The fibers can be grouped into traditional buffer tubes or cell structures for easy identification. Additionally, with the increased number of fibers, a self-supporting effect is created that permits the fibers to carry an increased amount

of external load, which further reduces excessive reliance on expensive and space-consuming strength members.

## BRIEF DESCRIPTION OF THE DRAWINGS

The advantages, nature and various additional features of the invention will appear more fully upon consideration of illustrative embodiments of the invention which are schematically set forth in the drawings, in which:

Figure 1 is a cross-sectional view of a typical fiber optic cable;

Figure 2 is a perspective view of a buffer tube with optical fibers, made in accordance with the present invention;

Figures 3 and 3a are, respectively, a perspective view of a buffer tube with optical fiber ribbons positioned inside the buffer tube, and a front view showing optical fiber ribbons positioned on an outside of a buffer tube, made in accordance with the present invention;

Figure 4 is a perspective view of a fiber optic cable stack made with a plurality of buffer tubes;

Figure 5 is a front view of a fiber optic cable configuration made with a plurality of stacks, according to the present invention; and

Figure 6 is a perspective view of a piece of composite tape with optical fiber ribbons, which is used to show a method of making the present invention.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will be explained in further detail by making reference to the accompanying drawings, which do not limit the scope of the invention in any way.

An embodiment of the present invention is illustrated with reference to Figure 2. A wound piece of composite tape 12 is provided to form a tubular shaped element or buffer tube

10. The composite tape 12 serves as a strength member to contain optical fibers 14. The optical fibers 14 are positioned in the buffer tube 10 according to the method described below. A gel or foamy glue 16 may be provided within the buffer tube 10 for filling the air gaps and positioning the optical fibers 14. The buffer tube 10 formed from the composite tape 12 according to the present invention acts to support and protect the fibers from external forces. The composite tape can be of the type known in the art, and which has adequate tensile and compression strength properties. The composite, by way of example, can be made by combining fibers of an organic mesh-type substrate with inorganic dot-type ceramic materials for fire protection (such as Nextel 3M Flame Stopping Dot Paper). The color of the composite tape may vary to allow for easy identification of the fibers in color-coded buffer cells.

Sub a1 As shown in Figure 3, a buffer tube 18 may also be formed to contain optical fiber ribbons 20. The optical fiber ribbons 20 allow for an increase in fiber packing density within the given space created by the rolled composite tape 12. This is advantageous as higher packing densities allow for more fiber to be placed in a given diameter cable and thus more efficient use of existing cable ducts. Further, use of the optical fiber ribbons 20 provide easier fiber identification, maintenance and splicing when working on the fibers. The size of the optical fiber ribbons 20 may be varied depending on the particular application. Also, similar to the embodiment of Figure 2, a gel or foamy glue 16 may be provided within the buffer tube 18 for filling the air gaps and positioning the optical fibers ribbons 20. As shown in Figure 3a, it may also be advantageous to provide the optical fibers 14 or the optical fiber ribbons 20 on an outside portion of the rolled composite tape 12, such that the composite tape 12 is rolled to form a tube and optical fiber ribbons 18 are positioned radially on the outside

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portion of the rolled composite tape 12. This configuration provides particular benefits because stacks of ribbons are positioned on top of a light-weight cylinder made of a composite material. The cylinder is empty, thus the cable weight is reduced. Also, traditional thermoplastic or a new composite-tape layer can be used as an outer jacket to enclose the stacks of ribbons. In addition, the cavity of the hollow central tube can be used to run electric wires, or other elements typically found in hybrid telecommunication and power cables. Another benefit of this embodiment is that, when under radial compression, the hollow central tube does not embed into the ribbons, but rather deforms, and protects the fibers from excessive stress.

Figure 4 shows a stack 22 of buffer tubes 18 containing optical fiber ribbons 20. The stack 22 is bundled together by a piece of wound composite tape 24 that forms an outer jacket. The composite tape 24 serves as a strength and support member for the stack 22. Due to the physical attributes of the composite tape 24, it is possible to form the stack 22 to take on varies geometrical shapes. For example, as shown in Figure 4, the stack 22 may be formed to have a triangular shape.

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A gel or foamy glue 26 may be used to fill in gaps between the buffer tubes 18 and to hold the stack 22 together. Examples of suitable gel formulations include gels comprised of mineral oils and/or synthetic polyolefin oils combined with a polymeric thixotropy modifier or pyrogenic silica. Commercially available gel compounds include Mastergel R-1806 and R-1806LT. By bundling together multiple buffer tubes 18 to form a stack 22, a self-supporting effect is created that permits the optical fiber ribbons 18 to carry an increased amount of external load. Thus, when multiple fibers are disposed in a tube, they can carry loads themselves, with a minimized contribution from additional strength members, so as to

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form a self-supporting mechanism. Also, when the number of fibers per tube is increased, the required strength contribution from a fabric-composite wall is lessened, so the wall thickness can be reduced. This results in a reduction of reliance on expensive and space consuming strength members, which are traditionally used to provide stability and support to an optical fiber configuration. Although Figure 4 shows buffer tubes 18 containing optical fiber ribbons 20, it will be appreciated that various configurations of optical fibers can be used within the buffer tubes.

As shown in Figure 5, an optical fiber cable configuration 28 is formed with a plurality of sub-units or stacks 22 containing a plurality of buffer tubes 18 with optical fibers. The optical fiber configuration 28 includes an additional piece of wound composite tape 30 that serves as a strength member to form an outer protective sheath, and which bundles together a plurality of stacks 22. As stated above, the stacks 22 may take on a variety of shapes. In one embodiment, the stacks 22 are formed to have a triangular or trapezoidal shape that allows for them to be disposed radially inside of the wound piece of composite tape 30 in a space-efficient manner similar to pie charts.

The space between adjacent stacks 22 of the optical fiber configuration 28 may be filled in with a gel 32, which acts to reduce water penetration along the cable length, to hold the stacks 22 in place and increases the overall stability of the optical fiber configuration. It will be appreciated that the number of stacks 22 that can be positioned within the outer protective sheath 30 is dependent on the forming of the stacks 22 to have a shape which minimizes areas between adjacent stacks 22.

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The optical fiber configuration 28 may also have an axial member 34 that is centrally positioned with respect to the outer protective sheath 30. The axial member 34 is used to pro-

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vide further support to the optical fiber configuration 28, and can be used to hold and support additional optical fibers or other elongated elements such as electric power wire or power cable. In an effort to reduce the amount of thermoplastic present in the optical fiber configuration 26, the axial member may be formed from rolled composite tape, as described above with respect to the buffer tubes 10 and 18, and contain optical fibers 14, which may take the form of optical fiber ribbons 20.

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With reference to Figure 6, a method of making an optical fiber configuration according to the present invention will be discussed. First, the composite tape 12 is positioned in an unrolled condition. A gel or foamy type glue 38 is applied to an open face 36 of the composite tape 12. Optical fibers are then positioned on the composite tape 12. It is noted that Figure 6 shows the optical fibers in the optical fiber ribbon configuration 18, as discussed above with reference to Figure 3; however, various configuration of optical fibers may be used. After the optical fiber ribbons 18 are placed on the composite tape 12 containing the gel, the composite tape 12 is rolled or wrapped around the fibers so that a buffer tube 18 configuration is formed. A similar rolling process is then performed to form the stacks 22, and then to form the optical fiber configuration that is described with reference to Figure 5. The tape can be helically wrapped, or may be applied longitudinally.

Although the tape is described as being a composite tape, it will be appreciated that any tape having sufficient strength may be used.

Although the invention describes the use of buffer tubes, buffer cells, stacks and an outer protective sheath which are described as being formed from a wound piece of composite tape, it will be appreciated that one or more of these supportive members may be formed from the traditional thermoplastic materials.

Although the invention describes the formation of a unit of an optical fiber configuration, as shown in Figure 5, it will be appreciated that the optical fiber unit shown in Figure 5 can also be stranded around a common central strength member for example, helically, to form, for example a super-unit cable containing multiple units to form a cable having a larger number of optical fibers.

It is, of course, understood that departures can be made from the preferred embodiments of the invention by those of ordinary skill in the art without departing from the spirit and scope of the invention that is limited only by the following claims.